

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): An apparatus for monitoring a swing path and/or a golf club head angle at or near an impact location with a golf ball during a golf swing, comprising:

- a golf ball impact location for receiving a golf ball;
- a first array of sensors proximate to the impact location;
- a second array of sensors spaced apart from the first array behind the impact position along a swing path, the first and second array positioned such that a golf club swung in preparation for contact with a golf ball at the impact location will have a swing plane in angular relation to the first and second arrays;
- an image capture device consisting essentially of a single camera for capturing two or more images of the golf ball after impact with the golf club head; and
- a processor for receiving signals indicative of a temporal profile of which sensors the golf club head is over during the swing and for determining at least one of a swing path and a club head angle of the golf club based on said signals indicative of the temporal profile, the processor further for determining three-dimensional velocity of the golf ball by extrapolating perimeters of the image of the golf ball in two or more images taken using the camera, and by determining three-dimensional spatial positions of the ball in said images and calculating the three-dimensional velocity of said golf ball based on said three-dimensional spatial positions.

Claim 2 (original): The apparatus of Claim 1, wherein said first and second arrays include a plurality of sensors arranged substantially linearly and orthogonal to said swing plane.

Claim 3 (previously presented): The apparatus of any of Claims 1 or 2, wherein the processor is further for using the signals indicative of the temporal profile to determine a swing path of the club head between the first and second arrays during the swing.

Claim 4 (previously presented): The apparatus of Claim 3, wherein the processor is further for determining a take away swing path of the club head from the first array to the second array during the swing and a downswing path of the club head from the second array to the first array towards the impact location during the swing.

Claim 5 (previously presented): The apparatus of any one of Claims 1 or 2, wherein the processor is further for using the received signals to determine the angle of the golf club head during movement of the club head across the first array toward the impact location.

Claim 6 (previously presented): The apparatus of Claim 5, wherein the first array includes a back sensor that is positioned just behind the substantially linearly arranged sensors in the first array along a swing path of the golf club, for determining the club head angle.

Claim 7 (currently amended): An apparatus for monitoring a golf club head angle at or near an impact location of the club head with a golf ball during a golf swing, comprising:
an array of sensors arranged at an angle to a plane of a golf swing of a golf club head;
an image capture device consisting essentially of a single camera for capturing two or more images of a golf ball after impact with the golf club head; and

a processor for receiving signals indicative of a temporal profile of which sensors the golf club head is over during the swing and for determining a club head angle of the golf club based on the signals indicative of the temporal profile, the processor further for determining three-dimensional displacement of the golf ball by extrapolating perimeters of the image of the golf ball in two or more images taken using the camera, by determining three-dimensional spatial positions of the ball in said images and calculating the three-dimensional displacement of said golf ball based on said three-dimensional spatial positions.

Claim 8 (previously presented): The apparatus of Claim 7, wherein said array includes a plurality of sensors arranged substantially linearly and orthogonal to a swing path of the golf club head.

Claim 9 (original): The apparatus of Claim 8, wherein said array further includes a back sensor behind said plurality of substantially linearly arranged sensors.

Claim 10 (previously presented): The apparatus of any one of Claims 7-9, wherein the processor is for determining the club head angle and swing path.

Claim 11 (original): The apparatus of Claim 1 or 7, wherein said golf ball includes a marking that is at least partially in view of the camera for any rotational position of the golf ball.

Claim 12 (previously presented): The apparatus of Claim 11, wherein said marking is substantially a stripe at least halfway circumambulatory of the surface of the golf ball.

Claim 13 (original): The apparatus of Claim 11, wherein said marking is a closed loop around the surface of the golf ball.

Claim 14 (original): The apparatus of Claim 13, wherein said marking separates substantially equal hemispheres of the golf ball.

Claim 15 (original): The apparatus of Claim 12, wherein said marking separates substantially equal hemispheres of the golf ball.

Claim 16 (currently amended): The apparatus of Claim 12, wherein said processor automatically finds said marking on at least two images of the golf ball and calculates a linear extrapolation of said marking for each of said images of the golf ball.

Claim 17 (previously presented): The apparatus of Claim 16, wherein said processor calculates backspin on said ball based on a comparison of said linear extrapolation from at least two of said images.

Claim 18 (currently amended): The apparatus of Claim 17, wherein said processor calculates sidespin on said ball based at least in part on curvatures of said marking in the images of the golf ball on at least two of said images.

Claim 19 (currently amended): The apparatus of Claim 7, wherein said processor automatically finds a perimeter of each of said images of the golf ball and calculates a circumferential extrapolation of each of said images of the golf ball.

Claim 20 (currently amended): The apparatus of Claim 19, wherein said processor determines diameters of said two or more images of the golf ball based on said circumferential extrapolations of said two or more images of the golf ball and calculates a three-dimensional velocity of said ball based in part on a comparison of said diameters.

Claim 21 (original): The apparatus of Claim 19, wherein said processor calculates a diameter based on said circumferential extrapolation and calculates a three-dimensional velocity of said ball based in part on said diameter.

Claim 22 (currently amended): The apparatus of Claim 12, wherein said processor automatically finds a perimeter of the image of the golf ball in said at least two images and calculates a circumferential extrapolation of the image of the golf ball in said images.

Claim 23 (currently amended): The apparatus of Claim 22, wherein said processor determines diameters of the image of the golf ball in said two or more images based on said circumferential extrapolations of the image of the golf ball from said two or more images and calculates a three-dimensional velocity of said ball based in part on a comparison of said diameters.

Claim 24 (currently amended): The apparatus of Claim 22, wherein said processor calculates a diameter of the image of the golf ball based on said circumferential extrapolation and calculates a three dimensional velocity of said ball based in part on said diameter.

Claim 25 (original): The apparatus of Claim 12, wherein said processor calculates sidespin on said ball based in part on curvatures of said marking on said images.

Claim 26 (currently amended): The apparatus of Claim 25, wherein said processor calculates a circumferential extrapolation of the image of the golf ball in two or more of said images.

Claim 27 (currently amended): The apparatus of Claim 26, wherein said processor calculates three-dimensions of velocity based in part on a comparison of diameters of the image of the golf ball in two or more of said circumferential extrapolations.

Claim 28 (original): The apparatus of Claim 27, wherein said processor calculates sidespin based in part on curvatures of said marking on said images.

Claims 29 – 32: Canceled.

Claim 33 (previously presented): The apparatus of Claim 27, wherein said processor is further for determining three dimensional velocity based upon said three-dimensional spatial positions.

Claim 34 (previously presented): An apparatus for determining spin characteristics of a golf ball after impact with a golf club head comprising:

an image capture device consisting essentially of a single camera for capturing two or more images of the golf ball after impact with the golf club head; and

a processor connected with said image capture device;

wherein said golf ball has at least one marking that is at least halfway circumambulatory of the surface of said golf ball such that said marking is at least partially within the view of said camera for any rotational position of said golf ball when said images are taken; and

wherein said processor determines spin of said ball based on an automatic determination of at least one characteristic of only one of said markings on images captured only with said camera;

said at least one characteristic including curvature of said marking.

Claim 35 (original): The apparatus of Claim 34, further comprising one or more sensors for triggering the capturing of the images by the camera.

Claim 36 (original): The apparatus of Claim 35, wherein the one or more sensors are one or more photosensors that sense the club head as the club head moves past the one or more sensors during a downswing prior to impact with the ball.

Claim 37 (original): The apparatus of any one of Claims 34 or 35, wherein said marking is a closed loop around the surface of the golf ball.

Claim 38 (original): The apparatus of Claim 37, wherein said marking separates substantially equal hemispheres of the golf ball.

Claim 39.(original): The apparatus of any one of Claims 34 or 35, wherein said marking separates substantially equal hemispheres of the golf ball.

Claim 40.(original): The apparatus of any one of Claims 34 or 35, wherein said processor automatically finds said marking and calculates a linear extrapolation of said marking for each of said images.

Claim 41 (previously presented): The apparatus of Claim 40, wherein said processor calculates backspin on said ball based on a comparison of linear extrapolations from at least two of said images.

Claim 42.(original): The apparatus of Claim 41, wherein said processor calculates sidespin on said ball based at least in part on curvatures of said markings on said images.

Claim 43 (currently amended): The apparatus of Claim 34, wherein said processor automatically finds a perimeter of the image of the golf ball in at least one image and calculates a circumferential extrapolation of said image.

Claim 44 (currently amended): The apparatus of Claim 43, wherein said processor determines diameters of the image of the golf ball in said two or more images based on circumferential extrapolations from said two or more images and calculates a three-dimensional velocity of said ball based in part on a comparison of said diameters, and wherein said calculation is independent of an orientation of the circumambulatory marking on said images.

Claim 45 (currently amended): The apparatus of Claim 43, wherein said processor calculates a diameter of the image of the golf ball based on said circumferential extrapolation and calculates a three dimensional velocity of said ball based in part on said diameter.

Claim 46 (currently amended): The apparatus of Claim 35, wherein said processor automatically finds a perimeter of the image of the golf ball in at least one image and calculates a circumferential extrapolation of said image.

Claim 47 (currently amended): The apparatus of Claim 46, wherein said processor determines diameters of the image of the golf ball in said two or more images based on circumferential extrapolations from said two or more images and calculates a three-dimensional velocity of said ball based in part on a comparison of said diameters.

Claim 48 (currently amended): The apparatus of Claim 46, wherein said processor calculates a diameter of the image of the golf ball based on said circumferential extrapolation and calculates a three dimensional velocity of said ball based in part on said diameter.

Claim 49 (original): The apparatus of any one of Claims 34 or 35, wherein said processor calculates sidespin on said ball based in part on curvatures of said marking on said images.

Claim 50 (currently amended): The apparatus of Claim 49, wherein said processor calculates a circumferential extrapolation of the image of the golf ball in two or more of said images.

Claim 51 (previously presented): The apparatus of Claim 50, wherein said processor calculates three-dimensions of velocity based in part on a comparison of diameters of circumferential extrapolations from two or more of said images, and wherein said calculation is independent of any determined characteristic of the marking on said images.

Claim 52: Canceled.

Claim 53 (previously presented): The apparatus of any one of Claims 34 or 35, wherein said spin is a type of spin selected from a group consisting of backspin and sidespin.

Claim 54 (previously presented): The apparatus of any one of Claims 34 or 35, wherein said spin is backspin.

Claim 55: Canceled.

Claim 56 (previously presented): The apparatus of any one of Claims 34 or 35, wherein said spin is sidespin.

Claim 57 (previously presented): The apparatus of any one of Claims 34 or 35, wherein said processor is further for determining three-dimensional velocity of said ball.

Claim 58 (original): The apparatus of Claim 34, further comprising two sensors, said processor for receiving signals indicative of when the golf club is detected by each of the

two sensors and estimating when the golf ball will be within a view of said camera for capturing said one or more images based on the received signals.

Claim 59 (original): The apparatus of any one of Claims 35-36, wherein said one or more sensors include at least two sensors, wherein said processor receives signals indicative of when the golf club is detected by each of the at least two sensors and estimates when the golf ball will be within a view of said camera for capturing said one or more images based on the received signals.

Claim 60 (currently amended): An apparatus for determining ball velocity in three dimensions of a golf ball after impact with a golf club head, comprising:

an image capture device consisting essentially of a single camera for capturing two or more images of the golf ball after impact with the golf club head; and

a processor connected with said image capture device for calculating a three-dimensional ball velocity by determining circumferential extrapolations of perimeters of the image of the golf ball in two or more images obtained only by using the camera, by automatically determining and comparing three-dimensional spatial positions of the image of the golf ball in said two or more images, and by calculating three-dimensional velocity using said three-dimensional spatial position determination and comparison.

Claim 61: Canceled.

Claim 62 (currently amended): The apparatus of Claim 60, wherein said three-dimensional spatial positions are determined based in part on a determination of diameters of the image of the golf ball in said images.

Claim 63: Canceled.

Claim 64 (previously presented): The apparatus of Claim 60 wherein the processor is further for determining a three-dimensional spatial position of the geometric center of at least one image and for calculating the three-dimensional velocity based in part on said three-dimensional spatial position determination.

Claim 65 (previously presented): The apparatus of Claim 60, wherein said processor is further for determining three-dimensional displacement of said ball.

Claim 66: Canceled.

Claim 67 (previously presented): The apparatus of Claim 60, wherein said three-dimensional velocity is also based at least in part on a timing of the ball impact and the capturing of said images.

Claim 68 (original): The apparatus of Claim 67, wherein said three-dimensional velocity is also based on a three-dimensional spatial position of said ball at said impact location.

Claims 69 – 76: Canceled.

Claim 77 (previously presented): The apparatus of any one of Claims 60 or 64 , wherein said golf ball has a marking that is at least halfway circumambulatory of the surface of said golf ball such that said marking is at least partially within the view of said camera for any rotational position of said golf ball when said images are taken.

Claim 78 (original): The apparatus of Claim 77, wherein sidespin on said golf ball is determined based on curvatures of said marking in said images.

Claim 79 (previously presented): The apparatus of Claim 77, wherein said processor automatically finds said marking and calculates linear extrapolations of said marking in said images and determines backspin based on a comparison of said linear extrapolations.

Claim 80 (currently amended): The apparatus of Claim 77, wherein said processor automatically determines a circumferential extrapolation of the image of the golf ball in at least one image, calculates a three-dimensional spatial position from said circumferential extrapolation and determines a three-dimensional velocity based at least in part on said three-dimensional spatial position.

Claim 81 (currently amended): The apparatus of Claim 80, wherein said processor calculates a diameter of the image of the golf ball in said at least one image from said circumferential extrapolation and calculates a three-dimensional extrapolation based in part on said diameter.

Claim 82 (previously presented): The apparatus of any one of Claims 1, 7, 34, 60, or 64, wherein said apparatus also captures an image of said golf ball and said golf club at impact such that a relative orientation of said club with respect to said ball may be evaluated.

Claim 83 (previously presented): The apparatus of Claim 77, wherein said marking is substantially a straight line within a plane of the surface of the ball.

Claim 84 (previously presented): The apparatus of Claim 34 wherein said marking is a stripe.

Claim 85: Canceled.

Claim 86 (previously presented): A system for monitoring spin of a golf ball following impact by a golf club, the system comprising:

a golf ball having an elongated stripe thereon;

an image capture device consisting essentially of a single camera positioned to capture at least two images of the golf ball following impact by a golf club; and

a processor for finding the stripe in images captured only by the camera and for determining a spin of the ball based on at least one characteristic of the stripe in said images;

said at least one characteristic including curvature of said stripe.

Claim 87 (previously presented): The system of Claim 86 wherein only one camera captures images of the golf ball following impact by a golf club.

Claim 88 (previously presented): The system of Claim 86 wherein the ball includes only one stripe.

Claim 89: Canceled.

Claim 90 (previously presented): The system of Claim 86, wherein the processor is further for determining three-dimensional velocity of the ball following impact based on the position and dimensions of the ball in said images.

Claim 91 (previously presented): The system of Claim 90 wherein said processor is further for determining said three-dimensional velocity independent of characteristics of the stripe on said images of the ball.

Claim 92 (previously presented): The system of Claim 86 wherein said processor calculates a linear extrapolation of said marking in at least two of said images, and calculates backspin on said ball based on a comparison of said linear extrapolations.

Claim 93 (previously presented): The system of Claim 86 wherein said processor calculates sidespin on said ball based in part on curvatures of said marking on said images.

Claim 94 (previously presented): The system of Claim 86 wherein the processor is further for determining three-dimensional displacement of the ball following impact based on the position and dimensions of the ball in said images.

Claim 95 (previously presented): The apparatus of Claim 34 wherein said at least one characteristic further includes orientation of said marking

Claim 96 (previously presented): The apparatus of Claim 86 said at least one characteristic further includes orientation of said stripe.